Robotic Surgery in Crohn's Disease

Drew Gunnells, MD[1] Jamie Cannon, MD, FACS, FASCRS[1]

[1] Division of Gastrointestinal Surgery, University of Alabama, Birmingham, Alabama

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Address for correspondence Jamie Cannon, MD, FACS, FASCRS, Division of Gastrointestinal Surgery, University of Alabama, Birmingham, AL (e-mail: jacannon@uab.edu).

Abstract

Surgery for Crohn's disease presents unique challenges secondary to the inflammatory nature of the disease. While a minimally invasive approach to colorectal surgery has consistently been associated with better patient outcomes, adoption of laparoscopy in Crohn's disease has been limited due to these challenges. Robotic assisted surgery has the potential to overcome these challenges and allow more complex patients to undergo a minimally invasive operation. Here we describe our approach to robotic assisted surgery for terminal ileal Crohn's disease.

Keywords

- Crohn's disease
- robotic surgery

While medical management is the primary initial treatment for inflammatory bowel disease (IBD), surgical therapy will be required for many patients. 15 to 30% of patients with ulcerative colitis will eventually undergo resection, and up to 83% of patients with Crohn's disease (CD) will require an operation within 10 years of diagnosis; furthermore, almost half of the patients that undergo resection for CD will suffer a recurrence requiring a subsequent operation.[1,2] Both patient and disease factors make surgery for IBD inherently more complex. The inflammatory disease process of Crohn's and ulcerative colitis presents a technically challenging surgical field, and these operations can be fraught with high complication rates.[3] Patients often present with thickened, friable mesentery, which is difficult to manipulate and can result in increased blood loss, adhesions to peritoneal surfaces and other organs, abscesses, and fistulas to other organs.[4] IBD patients are also more prone to preoperative morbidity, such as chronic anemia, malnutrition, and immunosuppression. These factors can interfere with postoperative healing and contribute to postoperative complications. Thus, operating on patients with IBD can present a challenge for the surgeon.

The benefits of minimally invasive surgery (MIS) in colorectal disease have been well documented for several years.[5–11] However, despite the well-known advantages of an MIS approach, 77% of ileocolic resections for CD are performed via an open laparotomy incision.[10] Increasing the rate of MIS approach is particularly important in this patient population, who may potentially undergo multiple surgeries during their lifetime. Technology that can enhance the surgeon's ability to deal with the challenging IBD cases could possibly increase the number of operations performed in a MIS fashion. Robotic-assisted surgery (RAS) could be this technology. While there is a paucity of data on using robotic-assisted techniques in IBD surgery, RAS has been shown in multiple studies to have a similar safety profile to laparoscopic surgery,[3,12–20] with lower conversion rates.[14,18–20] The improved visualization and added dexterity available with the robotic platform may help overcome some of the technical challenges in IBD surgery.

Minimally Invasive Surgery and Crohn's Disease

There is data supporting the safety, feasibility, and short-term clinical benefits of MIS for CD; however, it is mainly for a laparoscopic approach. In 1995, Bauer et al reported that laparoscopic-assisted surgery in CD was feasible and associated with improved postoperative outcomes.[21] Despite this early evidence, minimally invasive techniques were slow to be adopted in IBD. This was likely because IBD operations are more difficult due to such features as inflammation, strictures, and fistulae. In fact, from 2000 to 2004, a study from the National Inpatient Sample database found only 6% of the patients with CD who underwent surgical resection had a laparoscopic procedure.[22] This number increased to 33% in a study from the National Surgical Quality Improvement Project (NSQIP) database, but clearly there is still much room for improvement.[10] Early randomized trials evaluating a laparoscopic versus open approach in ileocolic resection in CD

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showed reductions in morbidity and hospital stay[23,24] with no significant difference in long-term re-operation rates.[25] Several studies supported improved short-term outcomes and decreased complications with a laparoscopic approach.[10,11] These findings have been confirmed in meta-analyses.[9,26] The feasibility and benefits have been described for laparoscopy even in complex and recurrent IBD.[23,27,28] While rates of conversion to open surgery are significantly higher with complex or recurrent disease as compared with simple disease—25 to 42% versus 13 to 14%, respectively—patients have similar outcomes for redo resections as for index operations.[28–30]

Current Status of Robotic Surgery in Crohn's Disease

There is limited published data examining the use of robotic-assisted techniques in IBD, particularly considering CD. However, it supports that the approach is safe, feasible, and may add value. McLemore et al showed in a small case series that a proctectomy with restorative J-pouch could be performed safely.[31] Miller et al performed a case-matched review of 17 robotic versus laparoscopic proctectomies; although this study was limited in several aspects, the results showed no conversions with comparable outcomes, including anastomotic leak and mortality.[32] There are multiple small studies showing equivalent short-term outcomes and complication rates.[31–33] A case-matched comparison of robotic versus laparoscopic proctectomy for IBD showed no difference in postoperative complications, with a trend toward improvement in conversion rate, time to bowel function, and LOS with the robotic approach.[34] An observational study of 81 robotic versus 170 open IPAA from a single institution showed similar short-term outcomes with improved LOS in the robotic group, but longer operative times and higher readmission rates.[35]

Robotic Approach for Crohn's Disease

While the robotic platform can be applied to the broad spectrum of IBD, the most common operations performed are ileocolic resection for CD and restorative proctocolectomy for ulcerative colitis. We will review these procedures and the operative techniques in detail. We will discuss technical aspects of performing the resection with the two most often used robotic platforms, the DaVinci Si and the DaVinci Xi. While operative technique is the same, port placement is quite different with the two systems.

Robotic Ileocolic Resection

Terminal ileal disease is one of the most common indications for surgery in patients with CD, and is generally treated with an ileocolic resection with or without fecal diversion. This operation, similar to a robotic right colectomy, is well-suited to a robotic approach. A robotic approach can allow the surgeon to perform an intracorporeal anastomosis (ICA), which has been associated with decreased rates of postoperative ileus,[36–39] and allows the extraction site to be moved off the midline, decreasing incisional hernia rates.[36,40] An ICA also minimizes the amount of colon mobilization necessary, which can be particularly beneficial in the setting of CD. In performing an ileocolic resection for IBD, there is no need to mobilize any more ascending colon than is necessary for division of the bowel distal to the diseased segment. With an ICA, the ascending colon can most frequently be left in place, which reduces adhesion formation, and allows the duodenum to remain in the retroperitoneum protected by the right colon and its mesentery. Most fistulae to the duodenum in CD originate from recurrent disease in the terminal ileum following a previous ileocolic resection. These can be quite difficult to treat. By avoiding mobilization of the colon away from the duodenum, the rate of this complex, late occurring complication may be decreased.[41]

Using a DaVinci Si system, it is the author's preference to use two robotic arms, plus the camera arm. While the surgeon can choose to use all three robotic arms, as well as the camera arm, only using a total of three robotic arms minimizes external collisions of the arms. A 12-mm stapler port is placed in the epigastric region, at an appropriate angle to create an isoperistaltic side-to-side anastomosis between the terminal ileum and the ascending colon. A 10-mm camera port is placed to the left and cephalad to the umbilicus, and an 8 mm robotic port in the left lower quadrant. For this operation, we choose to use a 12-mm assistant port. This allows the assistant to easily pass larger caliber needles for suturing if needed, for the anastomosis or bleeding from the mesentery. The goal is to get as much space as possible between the operating arms to minimize collisions (►**Fig. 1**).

When using the DaVinci Xi system, external collisions are minimized, allowing the surgeon to easily use all four operating arms. Unlike on the Si system, the robotic arms

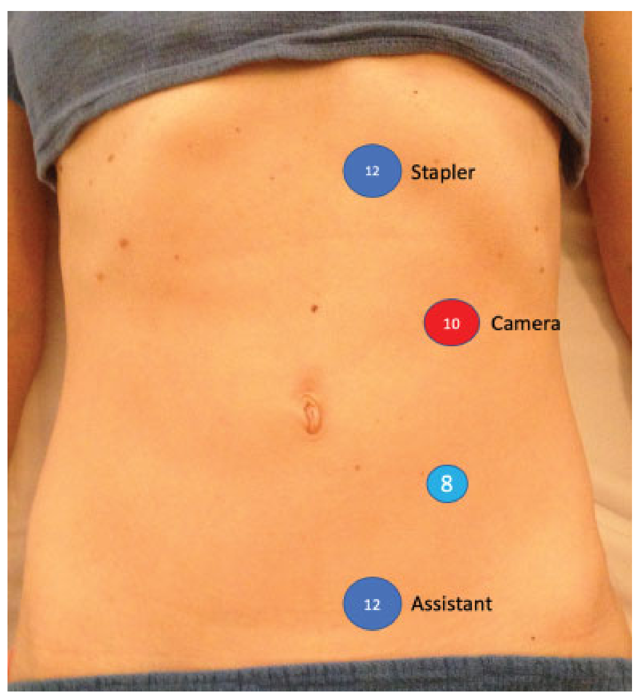

Fig. 1 Si port placement for ileocolic resection.

Fig. 2 Xi port placement for ileocolic resection.

all move in tandem, and as such, the ports are placed in a straight line across the abdomen, from the left upper quadrant to the suprapubic region. Once again, the cephalad most port is used as the stapling port. In the Xi system, 8-mm camera is used, and it can be introduced via any of the ports, though the authors preference is to use it primarily in arm 3. Once again, a 12-mm assistant port is placed laterally (►**Fig. 2**).

Unlike a formal right colectomy for malignant disease, the goal of an ileocolic resection for IBD is to mobilize the affected segments of bowel, and an extensive mesenteric mobilization is not necessary if dividing the mesentery intracorporeally and performing an ICA. For these reasons, we generally begin the operation via a lateral to medial approach. The terminal ileum tends to be densely adhered to the right pelvis. This can make the identification of the plane between the retroperitoneum and the mesentery quite difficult. Robotic visualization and precise dissection aid in this portion of the operation, but the surgeon must use caution not to enter the retroperitoneum if possible, and to be aware that the ureter can be involved in the associated phlegmon. The inflammatory response often results in significant oozing during lateral mobilization, which can interfere with visualization. If available, use of the robotic suction irrigator can be invaluable during this portion of the operation. If not available, a qualified bedside assistant can perform continuous suction (►**Fig. 3**).

Additional challenges during this portion of the operation include the presence of interloop abscesses and fistulizing disease (►**Fig. 4A, B**). Fistulae to the distal terminal ileum do not necessarily need to be taken down, as the inflammatory mass can be resected en bloc, although it does make management of the mesentery more challenging. It is common for other segments of bowel to be involved, with sigmoid colon being the most frequent. Other loops of bowel should be dissected away from the diseased bowel. If a fistula tract is present, the secondary segment of bowel can often be repaired primarily. The inflamed tissue around the fistula tract is excised, and the resulting defect closed primarily. The robotic approach aids in the ease of suturing the defect closed. The use of a barbed suture for this purpose frees the surgeon or the assistant from having to "follow" with another instrument. However, if the secondary loop of bowel is extensively damaged, it can be resected and an ICA performed. As this secondary segment is not affected by CD, the mesentery to this segment is generally normal and can easily be divided with the robotic vessel sealing device.

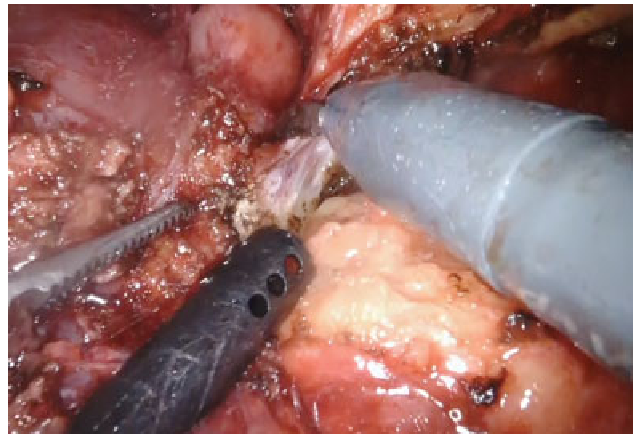

Fig. 3 Dissection of phlegmon out of the right pelvis.

Once the phlegmon and diseased bowel are sufficiently mobilized, the ascending colon and terminal ileum are divided. Healthy bowel proximal and distal to the diseased segment is identified and divided using the robotic stapler. At this point in the operation, the mesentery to the diseased segment is all that remains to completely free the specimen. Management of the thickened, diseased mesentery presents the greatest challenge of this operation. The vessel sealer can be used to divide the mesentery, although there will likely be bleeding from the mesenteric vessels, as diseased mesentery does not seal well with any currently available energy devices. The surgeon must therefore be prepared to deal with a bleeding mesentery. Because the robotic platform facilitates intracorporeal suturing, the mesentery can be oversewn in a manner similar to open surgery. The author's preference is to use a large caliber needle, such as a 0-Vicryl on a CT-1 needle. This can be introduced via a 12-mm assistant port and used to oversew the Crohn's mesentery with interrupted figure of eight sutures. This results in good hemostasis (►**Fig. 5**). Another trick to minimize blood loss with difficult mesentery is to place these stitches as U-stitches through the mesentery prior to dividing it.

Once the diseased segment is completely free, it can be laid aside in the abdomen where it is out of the way, such as

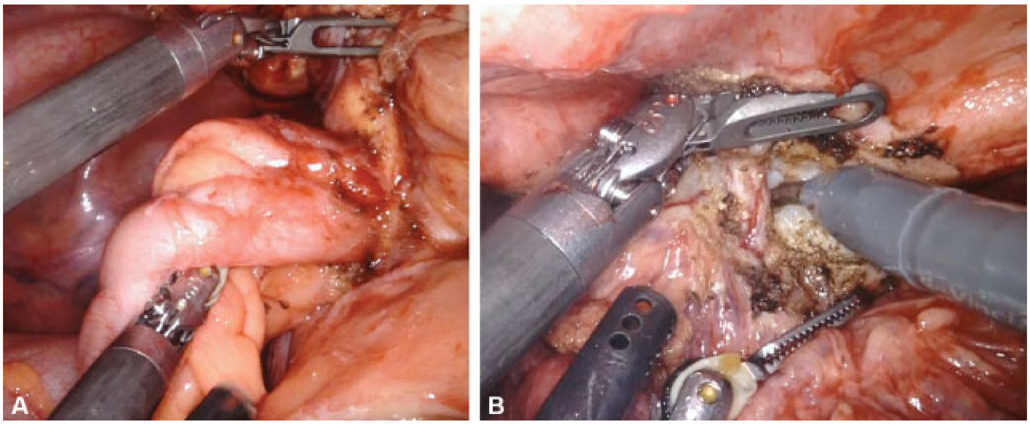

Fig. 4 Separation of enteroenteric fistula.

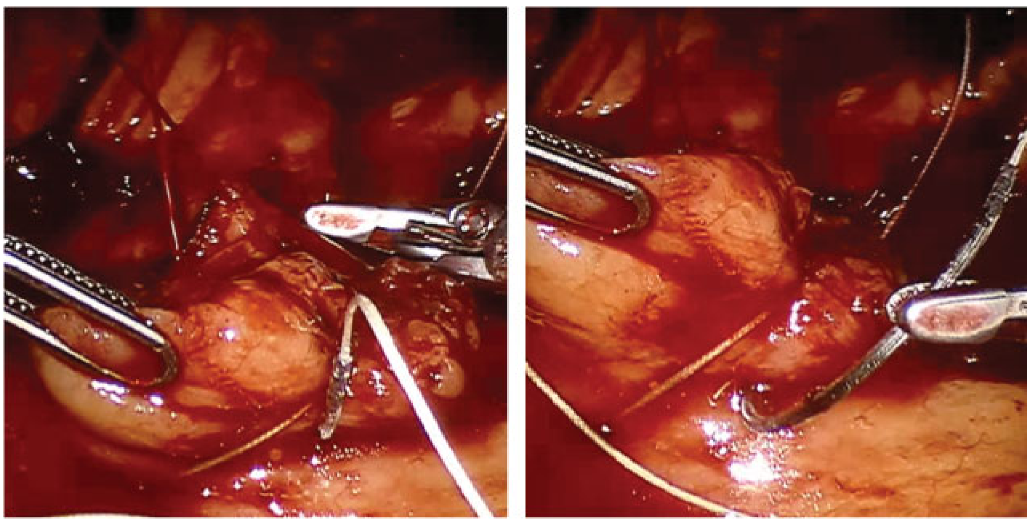

Fig. 5 Oversewing of bleeding from Crohn's mesentery.

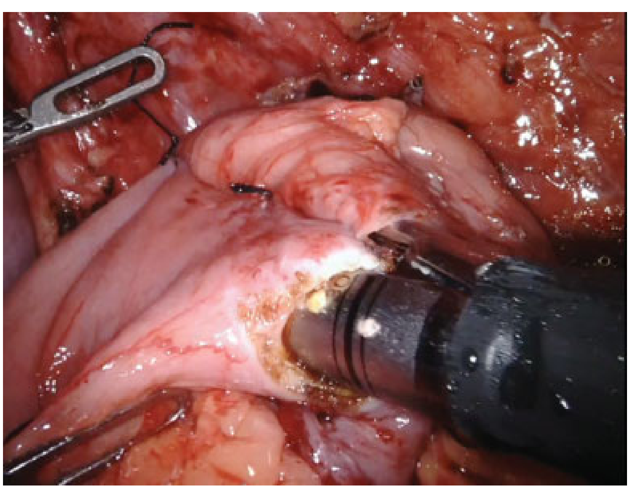

Fig. 6 Creation of a stapled side to side anastomosis.

over the liver in the right upper quadrant, for later extraction. The terminal ileum is aligned with the ascending colon in an isoperistaltic fashion. Seromuscular sutures are placed at the proximal and distal most aspects of the planned anastomosis to keep the bowel in alignment. An enterotomy and a colotomy are created at the distal most aspect of the planned anastomosis, and a side-to-side anastomosis is created with the robotic stapler. A single firing of the 60 mm robotic stapler creates a sufficiently sized anastomosis (►**Fig. 6**). The common defect from introduction of the stapler can be closed with a barbed suture, or stapled closed. If stapling the common defect closed, the author suggests placing stay sutures across the defect, and using these sutures to elevate the defect and staple underneath. The specimen can then be removed either via the ostomy site if diversion is planned, a pfannenstiel incision, or via a muscle splitting incision at the largest (stapler) trocar site.

Summary

Data on robotic surgery for CD is still evolving. Current literature teaches us that a minimally invasive approach to IBD offers benefits to the patient, but is associated with high conversion rates and has insufficient adoption. We propose that the improved visualization, instrumentation, and dexterity offered by the robotic approach will allow surgeons to overcome these difficulties and offer more patients an MIS approach in the treatment of CD.

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Conflict of Interest
Jamie Cannon is an instructor for Intuitive Surgical.

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